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CONDENSED DESCRIPTION OF REFRACTIVE AND ORTH-*OPTIC TECHNIC

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Sufficient has been written on the subject of binocular fusion and stereopsis for us all to realize that unless convergence, fusion, stereopsis, and accommodation are obtained without abnormal effort, either conscious or unconscious, comfortable single binocular vision cannot be enjoyed. Whenever any abnormal effort is required to exercise any of these functions, more or less discomfort, either direct or reflex, is experienced. Correcting refractive errors to produce the finest degree of visual acuity, or correcting refractive errors to the finest objective measurements does not necessarily produce comfortable vision. All of the faculties and functions connected with vision must be in normal coordination to permit normal comfortable binocular vision.

Many technics and instruments have been devised for the purpose of inducing and developing the faculties of fusion and stereopsis, and among them the most successful have incorporated the use of the stereoscope with stereoscopic pictures or images. The works of Wells, Worth, Sheard, Bestor, Maddox, Peckham, and others have covered the field very thoroughly and present the subject from all angles technical, theoretical, and practical. It is our purpose to present a proven successful method of applying Orthoptic corrective measures as advocated by these learned gentlemen.

The theory of the technic is well covered in the two publications, "The Stereoscopic Development of the Fusion Faculty," by Wells, and "Accommodative Convergence and Fusion Convergence," by Sheard. With these books as a foundation for the theory and general outline of the procedure, with some modifications, and with the necessary instruments for the application of the treatment, it is not difficult to diagnose and successfully apply the requisite Orthoptic treatment for correction of any of the visual anomalies.

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The Technic Is Divided Into Three Stages:

1st. Diagnostic, where we find out what is wrong.

2nd. Corrective, where we prescribe the necessary refractive correction.

3rd. Development, where we apply Orthoptic treatment to develop the necessary correct functioning of the faculties.

Our diagnosis is made with the Ophthalmoscope, Skiascope, Ophthalmometer, Colorfield screen, Phorometer, and visual acuity tests, and general history. The corrective test is made subjectively, with due consideration to the objective measurements and previous history. The Development treatment is given with the Phorometer and Orthoptic Instrument.

The object of the complete technic is to provide the simplest, and at the same time the most comprehensive method of inducing single comfortable binocular vision, with the least possible amount of annoyance and discomfort to both patient and practitioner.

Description of the Orthoptic Instrument

Before giving a description of the technic used, we want to describe the instrument used to develop and exercise the functions of the eyes.

This instrument, developed and patented by Drs. A. S. Hendrick and W. E. Tait, will, in a few months, be placed on the market by one of the manufacturers of optical instruments. Its purpose is to develop orthoptic action in the eyes through the faculty of stereopsis. The instrument is essentially simliar to a Wheatstone stereoscope, mounted on a pivot which swings from side to side. Stereoscopic images are projected on the mirrors from lighted targets placed at the side out of the line of sight. The eyes follow the movement of the targets, which starting from a position where the images are fused easily, gradually separate and then converge again, thus producing an action similar to a rotary prism.

The theoretic action on the faculties is the same as the Wells cards, with the Phorometer, except that no prisms or auxiliary lenses are used. Automatic mechanical action increases and decreases the amount of prismatic effect, and at the same time produces lateral motion.

It is well known that moving objects are more easily fused than stationary objects, and suspenopsia is much more easily overcome with moving fixation objects than with stationary objects.

Vision and motility in an amblyopic eye are much more quickly developed when used naturally, as in viewing moving objects which catch the sensitive points in the indirect field, than when directed at a fixed point.

In convergent strabismus, with the targets adjusted so as to fall on the most sensitive visual point on the retina, fusion and stereopsis are more quickly developed while the eyes are in motion than they would be if the targets were stationary.

The whole technic for developing convergence, accommodation, motility, fusion and stereopsis, has been built around the action of this instrument, and during the past two years, some remarkable results have been accomplished.

One advantage of the instrument over others based on the same theory for developing fusion, etc., is that the patient can be left alone for periods of from ten to thirty minutes while taking treatment, while the practitioner is attending to other patients.

Description of Technic

The instruments used in the technic are as follows: Ophthalmoscope, Ophthalmometer, Colorfield screen, Skiascope, Phoroptor, Phorometer, trial case, distant and near test letters, W. E. Tait acuity chart and Orthoptic Instrument.

General Procedure

The first essential is the previous history of the case, including symptoms, sicknesses and disease, previous treatment, diet, living and working habits. Next the Ophthalmoscope and Colorfield tests. Then visual acuity without glasses, visual acuity with glasses previously worn; phoria, distant and near; ductions, distant and near, without glasses; Skiascope measurements; Ophthalmometer measurement; subjective refractive tests, distant and near; phoria and duction with glasses.

From these findings is decided the corrective measures to be given; either permanent correction to be worn or Orthoptic treatment.

Details of Procedure

Sufficient has been written on the subject of pathology of the eye, for us all to realize that an unhealthy eye cannot enjoy clear, comfortable vision. Therefore the external and internal examination with the ophthalmoscope is the first essential. Following this a colorfield chart is made with a colorfield screen or perimeter. The subject of colorfield analysis is a subject in itself too comprehensive to enter into in detail at this point, but it should not be neglected as subsequent corrective procedure is largely dependent upon its findings.

Visual Acuity Test

The Visual Acuity test is standard procedure made at 20 feet with Snellen Type. First each eye singly, then both together. Near point acuity test is made with a standard reading card. Acuity is first measured with the naked eye, then with the correction which has been previously worn.

Phoria Test

Esophoria and Exophoria are measured by placing a 5 degree prism base up or down before one eye. A spot of light about 40 mm. diameter is used for distant fixation. The amount of prism necessary to line up the spots vertically is the amount of phoria recorded. Hyperphoria is measured in a similar manner, except that sufficient prism base in is used to produce diplopia, and the amount of prism base up or down recorded as the amount of hyperphoria.

Ductions

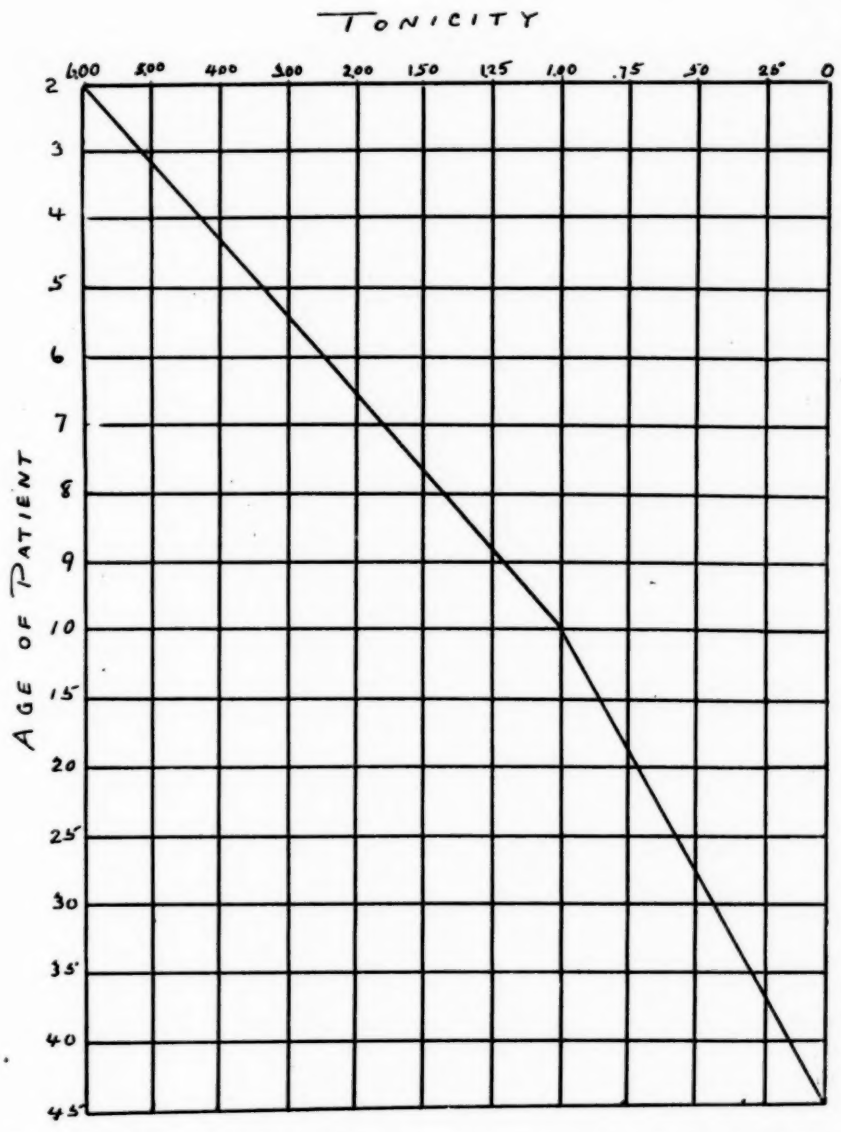
Duction is measured from the point of orthophoria. The phoria fixation spot is first lined up with prisms, if necessary. Then the attention is called to the 200 ft. letter on the distant test chart. The amount of prism base out with which the letter remains single is the measure of the adduction. The amount of prism base in with which it can be held single is the amount of abduction. No attempt is made to hold accommodation in check in making the duction test. The object sought is the extreme point at which fusion can be held. In the test made in this manner, adduction should range from 24 to 60 degrees in order to assure comfortable binocular vision at all distances. Abduction should measure from 4 to 10 degrees. If adduction is lower than 20 degrees, exercise on the Stereo-orthoptor is given and adduction built up to at least 30 degrees. If adduction responds within a few treatments, attempt is made to build it up to 40 degrees or more. Ten daily exercises should build up adduction to 40 degrees or more. After the first five exercises, considerable improvement should be manifest.

Ciliary Tonicity

Ciliary tonicity is the measure of the reserve flexibility of the ciliaries when fixing at distance. It may be divided into two classifications, latent and manifest. At the age of four, there is a latent tonicity of about four diopters. At the age of ten, the amount is one diopter. At the age of forty, there is very little tonicity. The tonicity chart which is used, is calculated for a distance of 26 inches with the skiascope which is used with this technic. The chart shows the normal amount of tonicity for the age. Any great deviation is an indication of some refractive or innervational anomaly. Manifest tonicity is shown by the difference between the static skiascope findings and the weakest subjective correction which permits maximum acuity.

A hyperope who can see equally well with plano or plus 1.00 has a manifest tonicity of one diopter. A person who can see equally well with plano or minus 1.00 has a manifest tonicity of one diopter.

To measure the amount of total tonicity, the dynamic skiascopic correction is first placed before the eyes. With this correction in place, the Tait Acuity Chart is used at 4 meters, and the correction adjusted to give maximum acuity. This we call the subjective correction. Should the difference between the subjective correction and the ob-



jective correction be more than as shown on the chart, it indicates undercorrected hyperopia and overcorrected myopia. In such cases relaxation exercises on the Stero-orthoptor are given to relax the ciliaries, thus permitting more plus correction for distance.

Should the difference be less than indicated on the chart, it indicates overcorrected hyperopia, ciliary spasm, or hypotonicity, and usually is accompanied by insufficient ductions and convergence. In such cases exercise to build up ductions and general innervation are

given on the Stereo-orthoptor. As adduction and convergence build up, the ciliary tonicity will increase in proportion.

High manifest tonicity indicates general nervous hypertonicity. Such cases respond readily to Stereo-orthoptor treatment. Low manifest tonicity in juveniles indicates general nervous debility. Such cases require general tonic treatment to build up the general nervous system.

High latent tonicity indicates high reserve and possible uncorrected hyperopia or overcorrected myopia. If such cases have low adduction or convergence, they will respond readily to Stereo-orthoptor treatment. With high adduction and convergence, full correction of hyperopia and astigmatism is indicated. Low manifest tonicity indicates possible ciliary spasm, general nervous debility and hypotonicity. In general, Stereo-orthoptor exercises should be given to induce relaxation or stimulation, as indicated, until tonicity, adduction, abduction and convergence are as near normal as can be induced.

Ciliary Cramp

With ciliary cramp, contraction and relaxation of the ciliaries is limited. Very often accommodation is entirely absent and very little if any manifest tonicity is found. Cases will be found where there is high latent tonicity, but where considerable discomfort is experienced at close work, or where no cylinder will be accepted when astigmatism is indicated with the ophthalmometer; or again when any slight change in sphere decreases acuity. Such cases are indications of ciliary cramp and should be given Stereo-orthoptic exercise to relax the ciliaries before prescribing. After exercising, the strongest sphere acceptable should be prescribed for close work while taking Stereo-orthoptic treatment until the ciliaries relax to somewhere near the objective measurements.

Skiascopy

The method of skiascopy used is the result of ten years research and practice, and has produced very consistent results during the past two years. The general theory of the method is well covered in Sheard's treatise, "Static and Dynamic Skiascopy." There is one point, however, which Sheard mentions, and which the writer has found to be of the utmost importance, i. e., *the position of the light source.* To produce accurate results, it is necessary that the source of light be at the same distance from the observed eye as the point of fixation, otherwise there will be a lack of definition of the reflex. The farther the light source is from the point of observation, the hazier the definition and the greater the margin of error in the findings.

For instance, if a plain mirror is used, and the light is placed behind the patient, with observation at 26 inches, the incident rays from the mirror will have a value of minus .75 at the patient's eye. In this case when the observed retina is conjugate with the eye of

the observer, the rays from the light source will focus .75 in front of the patient's retina. This creates a large diffusion circle which makes accurate refraction impossible.

With the source of light at the same distance as the point of observation, both beams will have the same conjugate point and will both focus on the retina of the patient, thus creating maximum definition and finest distinction of motion which permits much closer refraction. *This is very important in cases of low astigmatism.*

The writer, while experimenting and developing this technic, refracted one patient with five skiascopes of different makes. The results all varied from .50 to 2.00 diopters. The incident rays from the mirror to the eye in these instruments, varied from plus 1.00 to minus 8.00 diopters.

With a parallel ray, slight motion is barely distinguishable and errors of less than 1.00 are not distinguishable with any degree of accuracy. To quote Sheard, "The position of the apparent source of light may make a failure of what would otherwise be a successful and delightful use of skiascopy."

In some makes of streak retinoscopes, the divergence of the beam of light may be varied by an adjustable slide on the instrument. In such instruments the value of the findings varies with each change of light divergence, as well as with the observation distance.

In many of the self-illuminated instruments, a change in the light bulb makes a difference of as much as two diopters in the divergence of the beam of light projected.

With such variations it is impossible to make accurate refractions or comparisons.

It is necessary that the beam of light projected from the mirror be of a constant ray value, with the apparent source as close to the point of observation as possible, and that the ray value be known and allowance for the difference between this value and the observation point be made in calculating the findings.

The instrument used by the writer has the incident beam of light adjusted so that at 26 inch working distance, the apparent source of the light is 28 inches from the observed eye. With plus 1.50 sph. before the eye, the shadow is refracted until reversal is seen. In this condition, the conjugate of the retina would be plus 1.75. As the incident ray focuses 1.43 from the eye, the neutral point would be between the two at 1.50 or 26 inches. Removal of plus 1.50 from before the eye would leave it emmetropic.

Static Skiascopy

In making the static skiascopic examination, fixation is at a distant fixation point just over the head of the observer. In order to disassociate fusion and convergence, and inhibit accommodation, a twelve degree prism base down is placed over the opposite eye. This

permits the fixing eye to see the fixation target while the eye under observation is directed straight at the skiascope.

In this manner the eye is refracted as described by Sheard until reversal is the same in all meridians. Reversal is stopped at the last quarter diopter lens which actually produces reversal.

Dynamic Skiascopy

The dynamic refraction is made at 26 inches. Both eyes are directed at a fixation target attached to the skiascope, and the patient is directed to tell as soon as the figures begin to blur.

Both eyes are refracted together. The strongest plus which shows *with motion* is the measure of the refraction at this distance, with the usual amount of accommodation and convergence used habitually at this distance.

It is from these two findings in conjunction with the near and distance phoria and duction tests that we base our diagnosis and subsequent procedure.

The amount shown by the dynamic test is the amount which will eventually be worn at distance. It is the amount of reserve which we have to draw upon. If there is a great difference between the static and dynamic findings, it is indicative of latent or spastic condition. If accompanied by lack of extrinsic muscle balance or co-ordination, it will usually relax under orthoptic treatment.

If all of the faculties are functioning normally, there may be a difference of not over 1.00 between the static and dynamic findings if made as described. We expect to find a normal tonus of about this amount.

Before recording skiascopic measurements by this method, plus 1.50 is deducted from the static measurements and plus 0.75 from the dynamic.

Wherever skiascopic findings or objective measurements are mentioned in this treatise, it is the measurements with the above deductions.

The difference between the minimum plus found subjectively, and the static skiascope findings is considered as manifest tonicity.

The difference between the static and dynamic measurements is considered as latent tonicity. The total difference between the subjective and the dynamic measurements is the total tonicity and should be close to the amount shown on the tonicity chart.

The tonicity shown, and the deductions made are for the instrument used in the development of this technic. Instruments having different incident rays will require different calculations to be exact.

Corneal Astigmatism

We know that corneal astigmatism is a big factor in influencing ciliary action. We know that astigmatism with the rule is invariably

more or less suppressed or covered up by lenticular astigmatism in the opposite meridian. We know also that astigmatism against the rule is usually relaxed and fully correctable with lenses.

The fact that ciliary spasm and pseudo myopia are usually accompanied by deficient adduction and accommodation; and that inhibited or latent astigmatism with the rule is usually accompanied by deficient adduction, leads us to believe that the incentive for fusion and stereopsis is a controlling factor in what may be termed, ciliary spasm along with horizontal meridian.

The Javal, and other sliding scales for ophthalmometer corrections, are not consistent, and do not explain why astigmatism with the rule should be suppressed or covered up, while astigmatism against the rule is nearly always totally manifest.

There is undoubtedly some amount of physiologic astigmatism in nearly every case. The amount is so variable that it is impossible to set any empirical rule for it. It varies from nil to as much as 40% of the true ophthalmometer measurement.

Comparison of records refracted by our method, covering a period of over seven years, shows that in hyperopia, from 60% to 100% of the total corneal astigmatism with the rule will become manifest, and is correctable with lenses.

Neumeuller has calculated the effective value of ophthalmometric measurements at the lens surface, and finds that the influence on the cylindric value is not over 0.50.

He also does not find any definite amount of physiologic or lenticular astigmatism which may enter into the calculations.

As we understand it, his rule is to deduct plus .50 from *with the rule* findings up to two diopters, and additional .25 for each diopter above that amount. *Against the rule* he adds plus 0.50 up to two diopters, and additional 0.25 for each diopter above that amount.

The rule which we have followed for the past two years, and which has proven correct in 90% of cases, is to take 65% of the ophthalmometer finding *with the rule*; and 125% of the ophthalmometer finding, *against the rule*. This applies to *hyperopic* cases. In true *myopia* of 1.00 or more, the full ophthalmometric measurement is used.

Astigmatism

The theories concerning astigmatism are legion.

This technic is concerned principally with its correction and the relief of reflex symptoms caused by it.

Where there is no contributing pathologic cause as in Glaucoma, Pterygium, Ulceration, Inflammation, etc., of the cornea or surrounding tissue, we consider corneal astigmatism as physiologic, and amenable to correction with lenses and orthoptic treatment.

The ophthalmometer is our means of obtaining the nearest practical measurement of corneal astigmatism or malformation. With this measurement as our base, we endeavor to induce the ciliaries through their correlated nervous system to relax to as near normal as possible.

We do not attempt to create a new physical condition in the crystalline lens. We simply do our utmost to induce the lens to return to its normal relaxed condition.

In nature, the principal meridians are vertical and horizontal. Our autonomous nervous system does all it can to make these two meridians balance. In the interest of binocular vision and stereopsis, through their reflex connections, the whole nervous system strains to produce clear vision in all meridians.

In astigmatism *with the rule*, in the interests of clear vision and maximum comfort, the accommodation, with the aid of adduction and stereopsis, attempts to balance the vision in both meridians.

If the astigmatism is low, the ciliaries cramp up and overcome it completely with the accompanying asthenopia usually found with low astigmatism. If the astigmatism is high, they overcome all they can and become cramped in that position. Hence the apparent latent astigmatism found with hyperopia.

In astigmatism *against the rule*, as we have no stereoscopic vision vertically there is no incentive for contraction vertically. Hence we find that in astigmatism *against the rule*, the full ophthalmometer measurement will be accepted.

In myopia the same rule applies. Any attempt of the ciliaries to contract to clear up astigmatism results in dimmer vision in all meridians, so we find in true myopia, nearly always the full ophthalmometer measurement accepted.

In pseudo myopia, with astigmatism with the rule, we usually find the same condition as hyperopia. In true myopia we usually find the astigmatism all manifest.

Correction of Astigmatism

In correcting astigmatism, we first make the eye myopic, if it is not already so, by placing sufficient plus sphere before it to reverse the skiascopic movement in all meridians.

We then refract the eyes statically as described under "Skiascopy," leaving just sufficient power in place to produce reversal equally in all meridians.

Next, we refract them dynamically to the point where slight with motion is seen equally in all meridians.

The eyes are then refracted subjectively with the Tait acuity chart.

This chart had five principal targets, one for each of the prin-

cipal meridians, and one for central fixation. We first place the chart, which is on a portable stand, at 4 meters. If the targets appear fogged, we approach it to 3 meters, if still fogged, it is approached to 2 meters, or closer if necessary.

If targets appear uneven, a slight adjustment of the cylinder may be necessary to even them up. The lateral targets are first balanced by shifting the axis of the cylinder. The vertical targets are then balanced by slight changes in the strength of the cylinder.

Having reached the point where all of the targets are equally visible, we have reached the point of correction of the manifest astigmatism.

If the amount of cylinder now before the eyes is 65% or more of the ophthalmometer reading, we are assured of all that will relax for the present. If less than 65% we can feel sure that exercise on the Stereo-orthoptor will relax the ciliaries and enable more to be corrected.

In astigmatism *against* the rule, more than the full ophthalmometer reading is usually accepted. Exercise on the Stereo-orthoptor will relax the ciliaries if they have become cramped up in an ineffectual attempt to clear up the horizontal meridian.

Having balanced the targets on the acuity chart, we now remove it to 4 meters and reduce the sphere, if necessary, until the targets are all visible. If the technic has been carried out carefully, the patient will now be emmetropic and reference to the distant test letters should show 20/20 acuity.

The whole process in making this examination should not take over ten minutes and with practice can be done in much less time.

Should the patient accept 65% or more of the ophthalmometer reading, we can rest assured that he will not suffer from any reaction or reflex trouble from the astigmatism.

Should less than 65% be accepted, we can expect continued asthenopia or neurotic symptoms until it is corrected.

In cases of irregular astigmatism or conical cornea, the nearest ophthalmometer measurement is put in place before the eyes, with the nearest dynamic skiascope measurement. The Tait acuity chart is then approached until at least two or the targets can be distinguished. The axis and strength of the cylinder are then modified until all the targets balance. The sphere is then modified, if necessary, until maximum acuity is obtained.

By placing the dynamic skiascope correction before the eyes, we expect the patient to be fogged, and to be myopic. This gives us two definite focal points to work from, the patient's retina and his P. R.

Astigmatism is always corrected first, thus leaving simple myopia to be finally corrected.

One chart only is used at a definite distance, either 4, 3, or 2 meters. This gives a definite P. R.

In the interests of standardization, the final V. A. test is made at 6 meters with standard Snellen type.

Thus in all measurements, we have a definite P. R. and P. P.

Using one chart only, which is portable, we can place it where we know it will be conjugate with the patient's retina, thus assuring us of a definite focus.

In using a fixed chart at twenty feet, we are dependent upon different sized types which, except in emmetropia, produce diffused images on the retina. With the Tait chart, if it is placed beyond the patient's P. R. the targets cannot be distinguished.

For instance: If a patient is fully corrected, and all the targets are visible at 4 meters, one-half diopter of myopia will make them all indistinct at all distances beyond 3½ meters. The patient either sees them or does not see them. Plus 0.25 will blot them out at 4 meters.

For illiterates and mentally deficient patients, or children, this test is especially useful as it does not require a great deal of intelligence or education on the part of the patient.

Correction of Hyperopia

The eyes are first refracted with the skiascope, dynamically and statically. Presuming that the ophthalmometer indicates no astigmatism, we proceed as for simple hyperopia.

Comparison of the static and dynamic skiascope findings with the subjective will show the state of the tonicity of the ciliaries.

If phoria and duction are normal, both eyes should show the same difference between the static and dynamic findings.

If there is a difference, it usually indicates innervational imbalance of the accommodation.

Before lenses are prescribed, Stereo-orthoptic exercises are given to induce balanced relaxation to the point where both eyes show the same difference between the static and dynamic measurements.

Difference of more than plus 0.50 between the static and dynamic findings indicates ciliary cramp, latent hyperopia, presbyopia, or some duction insufficiency. Very seldom do we find a physiologic lag of more than this amount, if the skiascope technic, as described, is followed.

Any difference between the subjective findings and the static skiascope findings we consider to be due to nervous tension, and amenable to Stereo-orthoptic treatment.

In all cases showing more than normal differences between the static and dynamic skiascope measurement, careful investigation of

the status of phoria and duction is made. Also careful attention to color fields. Attention to diet and elimination to remove toxins in the system, and Stereo-orthoptic treatment to induce normal functioning of the extrinsic muscles are necessary.

Bearing in mind that the dynamic skiascope findings are the measurement of the normal refractive condition of the eyes in persons under presbyopic age, every effort is made to induce the eyes to accept this correction.

If it is possible for the patient to make daily visits for one to two weeks a temporary spherical correction is given, and daily exercises to relax the ciliaries and induce normal tonus is prescribed.

The strongest plus correction which can be tolerated is finally prescribed with instructions to return in six months for re-examination and correction. In very few cases have we found it necessary to change the correction within six months after Stereo-orthoptic treatment has been given. Usually within a few days, relaxation takes place and nearly the full dynamic skiascope correction can be prescribed.

In any case, real binocular comfort cannot be obtained unless all of the functions are near normal. Adduction, abduction, convergence, and accommodation must be within reasonable normal limits in order to permit comfortable single binocular vision.

Myopia

With true myopia, tonicity is low or entirely absent, and the full dynamic sphere will be accepted. Usually full ophthalmometer measurements will also be accepted.

With pseudo myopia, the full ophthalmometer measurement is not often accepted. Tonicity will be found nearly normal in many cases. If low or absent it indicates cramp.

With true myopia, adduction is often found normal, while with pseudo myopia adduction is usually low.

True myopia is usually accompanied by exophoria and low convergence.

Pseudo myopia is usually accompanied by esophoria and high convergence.

True myopes are usually of a relaxed phlegmatic temperament.

Pseudo myopes are usually tense and hysterically inclined.

Myopic pupils are large and dilated. In pseudo myopia, more often the pupils are contracted.

If possible, without reducing the V. A. too much, the skiascope sphere is prescribed. If this reduces vision too much, the weakest minus found subjectively is prescribed and tonic exercises on the Stereo-orthoptor given daily to develop accommodation.

As accommodation and tonicity develop, the distant correction is reduced just enough to permit sufficient distant acuity.

Reducing Myopia

There is little hope of reducing myopia until convergence, adduction, and abduction are built up to near normal proportions, and until tonicity is built up to some degree.

Without tonicity there is nothing to relax, and with high convergence and adduction strain, there is the accompanying reflex high accommodative strain.

With myopia accompanied by high adduction and normal abduction, contracted pupils, good convergence and tonicity of any appreciable amount, there is good prospect of inducing considerable reduction of the myopia.

With low adduction, exophoria, poor convergence, no tonicity, little hope of reduction can be promised until ductions and convergence are built up to normal proportions.

Normal ductions, tonicity, and convergence are just as essential in myopia as in hyperopia, and every effort should be made to build them up to normal.

Daily exercise on the exerciser, to develop adduction and convergence, and to build up accommodation and tonicity are given. The weakest minus correction with full astigmatic correction is prescribed. Vision is corrected to 3 meters with the acuity chart. This induces ciliary action for close work and inhibits progress of the myopia at distance.

Sufficient acuity is obtained at distance for use while treatment is being given. Lenses are changed as soon as the sphere can be reduced half a diopter at a time.

Correction of Myopia

In the correction of myopia the same preliminary examination is given as for hyperopia.

There is just as much necessity for normal functioning of the faculties in myopia as there is in hyperopia. Adduction, abduction and convergence must be as near normal as it is possible to make them.

Accommodation in myopia is usually weak. The dynamic skiascope measurements should indicate the correction which should be worn. If it does not reduce vision too much, it should be prescribed.

Stereo-orthoptic exercises should be given to induce normal functional balance and every effort made to induce development of accommodation and convergence.

If the visual acuity of the patient is too low for general use, as near the skiascopic correction as possible should be prescribed, and daily Stereo-orthoptic exercises given until vision improves.

Unless the dynamic test indicates myopia of 1.00 or more, minus is not prescribed until at least ten daily Stereo orthoptic treatments have been given, then if vision shows no improvement, the dynamic correction is prescribed.

If the patient cannot come for Stereo-orthoptic treatment, two pairs of lenses are sometimes prescribed. The dynamic measurement for close work and indoors, and the static for distant and outdoor wear. The patient is instructed to return at intervals of not over one month for re-examination and treatment.

As vision improves, the distant lenses are reduced until the dynamic correction can be worn for distant use.

Home exercises to develop convergence and adduction are prescribed, and at each visit, the progress of these functions are noted.

Stereo-Orthoptic Treatment of Myopia

In our technic for Stereo-orthoptic treatment of myopia, we divide the ages into three periods: juvenile, adolescent, and mature.

In juveniles, we are particularly careful with such cases as show considerable improvement in vision with the addition of minus 0.25 or minus 0.50.

All cases having 20/100 V. A. or better, which is greatly improved by the addition of minus 1.00 or less, are considered amenable to reduction with Stereo-orthoptic treatment.

We first make a careful skiascopic examination at 26 inches, making sure that fixation is being held. We then carefully check the near phorias and ductions.

Should there be more than 6 degrees of exophoria at 13 inches, or should there be less than 30 degrees of adduction at 13 inches, we prescribe Stereo-orthoptic treatments to induce normal balance of these functions. The dynamic skiascope findings are prescribed and worn during treatment. Distant adduction should develop to at least 40 degrees, and distant abduction to 8 degrees.

If the patient has been wearing minus lenses which are stronger than the dynamic findings, and which have given acuity of 20/20, it will be difficult to get the patient accustomed to less acuity. In such cases we impress upon them the necessity of wearing weaker lenses, and reduce them as much as will be tolerated. All cases which have worn more minus than necessary are more or less difficult to handle and require much patience and forbearance. By reducing the distant vision to 20/30 or less, if the patient will tolerate it, and by administering daily Stereo-orthoptic treatments, there is every hope of inducing the vision to clear up to normal.

In any case of true myopia, 20/20 is not normal or natural. If it is obtained it is at the expense of considerable nerve strain and is conducive to progression of the myopia.

If the patient has not worn glasses, and if the dynamic correction improves vision, this should be prescribed, and Stereo-orthoptic treatment given to induce normal ductions and phorias, which will reflexly induce maximum vision with natural ciliary balance.

At no tme should the patient be permitted to see better than can be obtained with the correction which will be prescribed. If the dynamic correction does not permit sufficient distant acuity for ordinary purposes, such as seeing the blackboard at school, etc., additional minus spheres in slipovers may be prescribed to be worn at times when better distant vision is necessary.

In such cases, prescribing the dynamic findings, with the distant difference in slipovers produces better results than prescribing the distant for regular wear and the dynamic addition for close wear.

A school student will not bother to put on the slipovers (which blur distant vision), for close work; but if it is necessary to put them on for distant use, they will do so only when absolutely necessary, and will take them off as soon as possible. Nobody enjoys wearing slipovers, so the inducement for wearing the stronger minus correction is removed, and they will be worn only when absolutely necessary to obtain clearer distant vision. This one particular point has been most productive in helping cases of pseudo myopia.

During the pre-puberal and adolescent period, or from 12 to 16 years of age, the whole physical and nervous system is upset, and the ocular system is subject to most peculiar changes. In treating myopes during this period, utmost care must be exercised. It is at this age when the greatest amount of close studying is done. This point alone contributes greatly to the progress of the myopia. In girls especially is this true, and close attention must be given to the previous history and to their physical condition. Stereo-orthoptic exercises should be given to induce normal ductions, convergence, and phoria. Especial attention should be given to relaxation exercises. Moving pictures, or sports or games requiring close concentrated vision should be barred as much as possible. Should acuity be too low to distinguish letters on the blackboard, just sufficient minus may be prescribed for this purpose temporarily if really necessary, but not more than enough to permit 20/50, or less if found sufficient.

If myopia is high, the dynamic findings may be prescribed for constant wear with sufficient minus in slipovers to permit distant vision if needed. Wherever possible, the dynamic findings, sometimes with slight modifications, are prescribed for constant wear.

It has been our experience with this technic, that in cases, at this age, showing manifest myopia of up to 2.00 D., after ten daily treatments on the exerciser, the myopia has shown considerable reduction and glasses for constant wear are unnecessary. We have also found that after development of adduction to some degree of normality,

vision will fluctuate from day to day, until the general physical and nervous systems have settled down to natural functioning.

If, during this period, Stereo-orthoptic treatment is kept up and the patient checked up at monthly intervals so that the functions are kept relaxed, there is less danger of the myopic condition becoming absolute and very favorable hopes of considerable reduction.

In no case should maximum V. A. be attempted, for once the habit of seeing with fine acuteness has been formed, it is difficult to overcome, and the same condition is induced as in hyperopes who have abnormal acute distant vision. Ciliary cramp soon ensues and the myopia becomes progressive.

In all myopic cases, regardless of age, consideration must be given to heredity, previous history, and colorfield analysis. Especially important is the constitutional history. Malnutrition, improper diet, wrong living habits, and especially glandular disturbances all contribute to a great extent to conditions conducive to myopia.

With myopia, after the age of adolescence, or from about 17 to 40 years, the physical system gets settled down and functions more naturally. With weak adduction or abnormal exophoria, it cannot be expected that comfortable binocular vision will be obtained. In any case of myopia, some attempt should be made to develop adduction, abduction, convergence, fusion, stereopsis, as well as accommodation, to as near normal as possible. Prisms should not be prescribed for constant wear until every attempt has been made to overcome the muscular imbalance. While prisms may temporarily overcome or relieve the strain of trying to hold binocular vision, they are not at all comfortable to wear, and create other reflex nervous disturbances.

If the patient has not been in the habit of obtaining high acuity with glasses, just sufficient for comfortable everyday use should be sufficient. As near the dynamic measurement as possible should be prescribed for constant wear, with extra minus spheres in slipovers for temporary use where more distinct distant vision is really necessary. 20/50 distant vision will be tolerated by most myopes, providing they have not been accustomed to better vision. This is sufficient for ordinary purposes. For use in picture shows, lectures, or for outdoor purposes where more distinct distant vision is really necessary, best results are obtained with minus spheres in slipovers for this purpose only, to be removed when it is not necessary to see at great distance.

In no case of myopia do we prescribe more than the dynamic skiascope findings. Stereo-orthoptic treatments are given daily to develop ductions and accommodation. As distant vision clears, minus sphere is used and slipovers are reduced until they are not necessary.

Subnormal accommodation usually accompanies myopia. If we push the P. R. back too far, the patient cannot accommodate suffi-

ciently to bring the P. P. within comfortable reading distance. We must therefore be careful in prescribing the distant correction, not to overdo it and give distant vision at the expense of near vision.

The most satisfactory way we have found is to first find the dynamic skiascope correction at 26 inches. With this in place, the patient is directed to read the letters on the reading card on the phorometer at 20 inches. The minus which first shows blurring of the type is the lens prescribed. This correction entails the use of the amount of convergence, adduction, and accommodation which is natural for this distance; and with it the patient will be able to read with the accustomed expenditure of energy. At nearer points, more accommodation and convergence will be required. At first, this will be tiring until the functions have built up the necessary strength. Stereo-orthoptic training will accomplish this in a short time.

Having fixed the near point at the maximum distance, it remains to fix the far point. If distant vision with the correction is not sufficient for practical use, minus spheres in slipovers may be used, just sufficiently strong to bring distant vision up to 20/50; to be worn temporarily until distant vision improves under Stereo-orthoptic treatment.

Presbyopia

The accepted standard of amplitude of accommodation provides that at the age of 45 the near point is about 3.00 diopters, or 13 inches. At this age there is normally no latent tonicity or reserve accommodation, and very seldom is there any manifest tonicity. Should there be any manifest tonicity shown by the tests as described, the full skiascope correction is prescribed and tonic exercises given on the exerciser to induce manifest tonicity and build up the adduction to its maximum.

Presbyopia, or the need of extra plus sphere for close work, can be delayed several years providing ample tonicity is built up in the years preceding 45. For instance, at the age of 45 there is usually no manifest tonicity, but, should there be manifest tonicity of 1.00 D., reading glasses will not be necessary. The full skiascopic measurement can be crowded on and Stereo-orthoptic exercises be given to keep the ciliaries active. Should the minimum distant correction be given, the ciliaries will not be able to overcome the strain of near vision and presbyopic addition will be necessary.

We have cases on record of presbyopia being delayed to the age of 47 to 50 before additional sphere for close work became necessary. Up to the age of about 35, manifest tonicity of 2.00 can be tolerated without much difficulty providing adduction and convergence are high. Should adduction be low, with manifest tonicity high, an imbalance is created which induces cramp and asthenopia. Stereo-orthoptic exercises to develop adduction should be given to relax the

ciliaries and restore balance. With high adduction, high manifest tonicity and good V. A. there is every possibility of delaying presbyopia several years.

After presbyopia has set in and the ciliaries have become weakened or ennervated from using reading glasses, there is still some hope of being able to reduce the amount of manifest presbyopia with Stereo-orthoptic exercise. The full skiascope measurement is prescribed. Bifocals should not be used constantly, and daily Stereo-orthoptic exercises should be given to build up innervation and induce ciliary activity. We have records where bifocals have been discarded after two years wear, and others where the presbyopic addition has been reduced considerably and distant correction increased.

Bifocals need not be fitted to patients between the ages of 35 to 45, providing the full astigmatic correction and skiascopic sphere is worn. It is much more satisfactory to delay prescribing bifocals until the ciliaries are fully relaxed and tonicity, adduction, and convergence built up to normal. Should bifocals be prescribed when less than 65% of the corneal astigmatism is corrected, or where there is uncorrected high manifest tonicity, they will not be accepted comfortably and will soon have to be changed.

Convergent Strabismus

With our technic for correcting strabismus, ***prisms or bifocals for constant use are not prescribed.*** Traumatic and post-operative squint can be decidedly benefitted with Stereo-orthoptic treatment, but the prognosis for complete correction is doubtful.

The general procedure in all cases of convergent squint is the same. The regular preliminary examination is first made and the ophthalmometer, and skiascopic measurements, V. A. and ductions are recorded.

Each eye is first refracted with the skiascope, the opposite eye being occluded and permitted to assume its natural position of rest. The eyes are then refracted subjectively, and the measurements recorded. If tonicity in both eyes is low, it is evidence that both eyes have become equally cramped. If tonicity in one eye is less than in the other, it is evidence that it has become cramped and has disturbed the binocular ciliary balance.

Alternating convergent strabismus usually accompanies hyperopia, astigmatism, hysteria, or ciliary cramp. The first necessity therefore is to induce relaxation.

To induce relaxation of the ciliaries, the strongest plus correction should be prescribed. If astigmatism is shown by the ophthalmometer, it should be corrected as fully as possible. If possible, the full dynamic skiascope correction should be prescribed. Relaxation exercises on the exerciser should be given daily.

If the pupils are contracted and do not relax with the lenses prescribed, Cruxite B. in slipovers may be used to be worn while in bright light. The object is to induce relaxation of all the functions. Attention should be given to diet and elimination, it being necessary that everything be done to induce thorough relaxation of the whole nervous system of the body.

Monolateral Squint

In monolateral squint where vision is good in both eyes, but one remains converged or suppressed, the dominant eye is fitted with an Orthoscopic bifocal to impel use of the suppressed eye until the habit of suppression is overcome. The vision of both eyes is then balanced again. Suspenopsia, or suppression of one eye is soon overcome with Stereo-orthoptic treatment.

Motility of the suppressed eye is apt to be low. In such case an Orthoscopic bifocal is fitted over the good eye. This enforces use of the suppressed eye when looking temporarily and soon builds up motility on the temporal side and overcomes the tendency to squint. Monocular exercise on the exerciser is given to build up innervation of the extrinsic muscles of the poor eye. As soon as the suspenopsia is overcome, relaxation exercises are given and as near full distant correction as will be tolerated.

Amblyopia

In cases of amblyopic squint, when making the skiascope examination, the good eye is covered in order to permit the amblyopic eye to fix. The amblyopic eye is corrected to give the best acuity possible compatible with the skisacope measurements. The good eye is fitted with as near the skiascopic correction as possible.

If vision in the poor eye can be corrected to 20/100 or better, sufficient sphere to fog the good eye to the same acuity as the poor eye is prescribed. If it is necessary that the patient should see at distance better than can be done with this correction, as for instance, at school, at the theater, church, or lectures, etc., a minus sphere of just sufficient strength to permit the required acuity may be fitted in slipovers, with plano over the good eye. This should be worn only when absolutely necessary, otherwise use of the poor eye will not be induced.

As the vision in the poor eye develops, the lens over the good eye may be reduced just sufficiently to keep the vision of the poor eye slightly better than the good eye. This will induce use of the poor eye and will greatly aid in its development. Stereo-orthoptic exercises are given daily until fusion and stereopsis are obtained, and continued until ductions and tonicity are built up to as near normal as possible.

Divergent Squint

Divergent squint has generally been considered uncorrectable with orthoptic exercises. We have been very successful with cases

as high as 20 degrees. Exotropia may be divided roughly into two classes: Those having some adduction and general tonus, and of a tense nervous nature, and those having no adduction, low tonicity, and general laxity, apparently too lazy to make any attempt to hold binocular vision. The first are the easiest to correct.

The preliminary examination is the same as for convergent squint. Each eye is permitted to assume its most restful position, and if necessary, the head is turned so as to bring the eye under observation into line with the examiner. If possible the static skiascope correction is prescribed. Stereo-orthoptic treatment is then given daily to build up fusion and convergence. If the divergence is too great to permit distant fusion prisms base-in may be prescribed in fitovers, just sufficient to permit fusion. These are to be worn as much as will be tolerated. As fusion reponds, Stereo-orthoptic treatment is kept up until adduction and convergence are built up so that near binocular vision can be held.

If one eye is amblyopic, the same procedure is followed as for convergent strabismus. The good eye is fogged to the same acuity as the poor eye and the amblyopic eye set to work.

In stubborn cases where vision nasalwards is suppressed and each eye persists in viewing the temporal field only, reversed orthoscopic bifocals may be prescribed. With these lenses, temporal vision is inhibited, and each eye can see on the nasal side only. This soon breaks up the habit of seeing with the eyes diverged and induces convergence.

In divergent cases, as in all others, accommodation, convergence, and ductions must be in harmony to produce satisfactory results. Effort must be made to build up these functions while inhibiting the habit of seeing things on the right with the right eye and on the left with the left eye.

In stubborn cases which do not respond to fusion at distance within reasonable time, prisms may be incorporated in the prescription for constant wear until the fusion habit is well established. They should then be reduced as much as possible while still permitting fusion without discomfort. Such change should not be made too rapidly, otherwise the eyes may swing back to their original position again before fusion is thoroughly established.

Alternating Convergent Strabismus

Of all the various types of convergent strabismus, the alternating type is the most difficult to correct. Usually, in these cases, the vision of the eyes is fairly good, and the refractive error not very great. If the squint was first brought about through a shock or concussion, or through sudden strain, as in coughing, etc., and if the faculty of fusion is temporarily lost or suppressed, there is very good prospect of restoring binocular vision with fusion training. This can be accomplished without much difficulty as soon as the cramp or tetanus which holds the eyes crossed is loosened.

If, however the squint is congenital, and the faculty of fusion has never been developed, more difficulty will be met with in developing this faculty. Usually in alternating squint the temporal field of vision of each eye is suppressed; the right eye takes in the left field, and the left eye takes in the right field. In use neither eye crosses the median line or rotates outwards. Regardless of the cause of the squint, there was evidently primarily a cramp in the interni caused possibly by a sudden intense innervation of the convergence centers. Owing to the muscles having remained in this cramped and contracted condition for a log period, structural changes have taken place which have actually created shorter interni or longer externi. The amount and permanence of this structural change is dependent upon the length of time the eyes have been in the condition.

The desire for single binocular vision having been lost, there has been no incentive for holding the eyes straight, and the habit of viewing the left field with the right eye, and the right field with the left eye having become so firmly established, there is no incentive for turning the eyes outwards further than the median line.

Fusion, stereopsis and single binocular vision are right habits which, in the natural course of events, will be developed in every human being having two seeing eyes. However, should something happen to interfere with the normal development of these faculties, the incentive for their development is lost and the faculty not developed. In such cases wrong habits are acquired, such as suppression of the vision of one eye, or use of the nasal field only in each eye and suppression of the temporal field in order to overcome the annoyance of diplopia. In order to correct the squint, we must overcome the wrong habits and induce cultivation of the right habits.

The first thing necessary is correction of any ametropia which may exist, so that vision may be had without accommodative strain, and to induce relaxation whatever reflex influence accommodation may have on the convergence. The next thing is to develop fusion, if possible. To do this daily exercise on the exerciser is given, first to produce diplopia, then to induce fusion and stereopsis.

Next suppression of the temporal field must be overcome. The exerciser is adapted for this purpose, and daily exercises for this purpose are given in conjunction with fusion training. After a few exercises with the instrument the habit of seeing with the temporal fields of each eye will become developed, which will aid materially in overcoming the bad habit of suppression.

In such cases where use of the temporal fields is slow in development, Orthoscopic bifocals are fitted to inhibit use of the nasal field and impel use of the temporal field. These lenses are worn constantly. With their use the patient is able to see in the temporal

side only, which necessitates outward rotation of the eyes and soon inhibits the habit of seeing with the eyes converged.

During this time, fusion exercises are kept up. As soon as binocular vision can be obtained, with the use of prisms base-out if necessary, they are prescribed to be worn in slipovers over the regular correction. The length of time necessary to produce manifest results is dependent upon the duration of the squint. The longer the squint has existed, and the more the muscles have contracted, the longer will it take to relax the tetanus and to stretch the muscles. The time is also dependent upon the amount of co-operation given by the patient. The more the patient uses the temporal fields, the sooner will the muscles relax and assume their normal position.

The number of cases where tenotomy has been performed on convergent squint, and subsequently, the eyes have diverged, supports the theory that alternating convergent strabismus is caused by cramp or tetanus of the interni, and that ciliary spasm or accommodative strain is not the major cause, though it may be a contributing cause.

It happens often that as soon as the tenotomy is performed either the surgical shock, or the actual severance of the muscle or part of it, creates relaxation of the muscle, or restores the normal innervation, and the eyes return to their normal position of balance, but, as the interni is longer, due to the severance of the muscle, the eye diverges.

Before giving up a case of alternating strabismus as hopeless, every effort should be made to locate the seat of the trouble. Every possible effort should be made to develop fusion. Exercise to induce or impel outward rotation of the eyes, to stretch the interni and to induce use of the temporal field of vision, should be given. Total relaxation of accommodation by prescribing the maximum correction should be given. Everything possible should be done to break up the vicious habit of seeing on the nasal side only, and of suppressing the vision of the opposite eye, and to build up and develop the habit of using the temporal fields of both eyes and of using them together. Alternating strabismus cannot be corrected in a short time, but, constant attention and co-operation of the patient, and correct orthoptic measures to develop the suppressed functions will usually show manifest results in a few weeks.

As soon as persons who come in contact with the patients notice the improvement in the appearance of the eyes, and remark upon it, results will be obtained much more quickly, as the patient then will feel more encouraged and will give more co-operation. Technical figures which show, on paper, improvement in duction, accommodation, etc., do not have much effect upon the patient, but, when their friends tell them that there is a noticeable improvement in the position or appearance of their eyes, they begin to sit up and take notice, and will then do more to hasten their own recovery.

Hypertropia and Hyperphoria

Hyperphoria is usually accompanied by other muscular and functional imbalance, and often disappears with the correction of the other anomalies. If persistent, daily exercise on the exerciser will soon bring about vertical balance.

In hypertropia of high degree, sufficient prism to just permit fusion is prescribed in fitovers to be worn as much as possible. Daily Stereo-orthoptic exercises are given.

As high as 30 degrees of hypertropia have been corrected with Stereo-orthoptic exercises alone. Amounts up to ten degrees are easily corrected and soon respond to Stereo-orthoptic treatment.

In hypertropia with exotropia, the refractive error should first be corrected and if necessary, prisms be prescribed in fitovers of just sufficient strength to permit fusion. Stereo-orthopic exercises are then given to develop fusion, duction, and stereopsis. As soon as fusion can be held without prisms, they are discarded and effort made to develop adduction to normal. If hypertropia persists it should be corrected temporarily with prisms in slipovers. If it still persists after fusion and stereopsis are established, prisms of just sufficient strength to permit comfortable fusion should be prescribed in the regular distant prescription.

In this technic we do not prescribe prisms for constant wear except in extreme cases after Stereo-orthoptic exercises have proven unsuccessful, and then only just sufficient to permit fusion without discomfort.

It has been our experience that prisms of over 5 degrees in each eye are very uncomfortable to wear and produce such reflex nervous strain as to neutralize their optical benefits.

General Stereo-Orthoptic Exercises

As an aid to relaxation of latent hyperopia and astigmatism, every patient is given five to ten minutes exercise on the exerciser before examination. When glasses are first delivered, five to ten minutes exercise induces rapid adjustment of the faculties to the new conditions.

In all cases where tonicity is low, or where at least 65% of the ophthalmometer findings are not accepted subjectively, ten to fifteen minutes exercise are given to relax the cramp and loosen up tonicity. In all cases of low tonicity, daily exercises should be given to build it up. All cases of low adduction or insufficient convergence should be given daily exercise until sufficient flexibility is induced. Comfort cannot be experienced with low nerve impulse, so every effort must be made to induce relaxation and stimulation of tonus or flexibility of all the functions.

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MINERS' NYSTAGMUS*

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It is not the purpose of this paper to present any new theories regarding the pathology or physiology of Nystagmus but it is hoped that it will shed some light on what has always been termed, "Miners' Nystagmus."

Innumerable theories have been presented to explain this peculiar condition and especially its aetiology. Before continuing with the purpose of the paper it might be well to review some of the more common of these theories as presented in the standard texts.

DeSchweinitz[1] defines and discusses nystagmus as follows: *"This term i. e., nystagmus, is applied to a condition characterized by an involuntary, rapid movement of the eyeballs. The movement may be lateral, vertical, rotary or mixed, i. e., a compound of two varieties. The condition may be congenital or acquired, and is bilateral in the vast majority of cases, although a few cases have been reported in which the nystagmus was unilateral, with the movements usually in the vertical direction. It is possible, however, inasmuch as slight forms of nystagmus are detected only by using the ophthalmoscope and watching the fundus, that some of these cases have actually been bilateral. The movement is nearly always in the lateral direction. According to Gowers, the extent varies from 1 to 10 mm. and the frequency from 60 to 200 separate oscillations per minute. Congenital Nystagmus is seen with cases of defective construction of the eyeball—Coloboma, microphthalmus, etc. It is also common in albinism. Nystagmus also occurs with opacities of the cornea and degenerations within the media, especially when such obstruction to the rays has been caused by diseases occurring in early life and in blind eyes. Nystagmus may be acquired by the pursuance of certain occupations, especially mining, and is commonly known as miners' nystagmus. It generally occurs among those who use a dim light, and whose work necessitates keeping the eyes in an unusual position for many hours together. (Snell.) Finally, nystagmus is exceedingly common in diseases of the nervous system, particularly disseminated sclerosis and Friederichs ataxia. It occurs in many diseases of the brain, and has been noted with great frequency in tumors of the cerebellum. Nystagmus has*

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been ascribed to chronic fatigue of the muscles and oscillation of the globe consequent upon the muscular atony and also to a central origin. In some cases it is probable that both explanations are correct."

Atkinson[2] in defining the types of nystagmus states, *"Nystagmus, rapid, involuntary oscillations of the eyeball. Usually due to central nervous disorders. It is termed vertical, lateral or rotary nystagmus, according to the direction of the oscillations. Aural nystagmus-spasmodic nystagmus due to disturbances in the internal ear. Miners' nystagmus—nystagmus occurring in coal miners, due to wielding a pick while lying on the side in a cramped position. When this nystagmus occurs upon turning the eyes downward it is called miners' nystagmus against the rule. Labyrinthine nystagmus—same as aural nystagmus."*

May[3] gives a description similar to that of DeSchweinitz but adds, *"It is found in miners, (miners' nystagmus); in these cases it is due to defective illumination and strain and exhaustion of the ocular muscles, because the eyes must be turned in unnatural directions, especially when predisposed by errors of refraction. Miners' nystagmus generally disappears when the patient gives up this kind of work."*

Numerous other authors whose texts have been reviewed by the writer, but whose opinions as to the aetiology of miners' nystagmus agree with those already given in this article are Jackson[4], Beacher[5], Gould & Pyle[6], and Duke-Elder[7]. Duke-Elder whose paragraphs upon postural reflexes present all the more recent theories regarding their physiology, hints that future investigation will probably reveal the cause or causes of nystagmus to lie in defects of the postural reflexes and their visual and labyrinthine connections.

Summarizing the various opinions we might say that nystagmus was the result of some obstruction to the proper focusing of the rays of light upon the macula, to a disturbance of the inner ear or to some central nervous disturbance or in the particular type, miners' nystagmus, to faulty illumination which would prevent macular fixation, or to the peculiar position in which it is generally supposed the miner is forced to hold his eyes, resulting in a condition of chronic fatigue of the extra ocular muscles. Most of the authors are agreed that singly or collectively these are the aetiological factors causing nystagmus.

The cases of true nystagmus with which the average practitioner is confronted in his office practice are usually few and far between. It is only to those working in clinics and such, that the opportunity of observing this anomaly presents itself, and even with the large number of cases met with in the clinics the percentage of cases presenting nystagmus is small. It is probably for this reason that very little definite investigation has been done and we have all been forced to accept the theories expounded in short paragraphs of the standard texts.

The writer, it so happens, is director of the Department of Industrial Visual surveys of the Pennsylvania State College of Optometry.

This department maintains a portable visual survey unit and has in the past two years examined the eyes of many thousands of Industrial workers by locating this unit right in the plant to be surveyed. These surveys have resulted in the securing of vast amounts of statistical data that will take some time to correlate.

A few months ago, under the auspices of the Anthracite Optometric Association our unit was located in a mine near Frackville, Penna., which employed over 600 miners. It was with the expectancy of seeing and studying a large number of cases of miners' nystagmus that Doctors W. O. Vivian, J. H. Morrow and H. Kline and the Director, commenced the survey of these 600 and some odd pairs of eyes, which according to all teachings were in the proper environment for the developing of nystagmus.

According to the teachings of the student texts, it is impossible to discern some cases of nystagmus, except by watching the fundus move when doing ophthalmoscopy. In the plan of survey outlined by the director each patient was seen by at least two of the examining doctors. The following routine was carried out in each case: Visual acuity with and without glasses; external examination; ophthalmoscopy; keratometry, and skiascopy. It must be realized that with this type of examination, a strictly optometric procedure, it would be almost an impossibility to miss a case of nystagmus, especially with the keratometer which will detect the slightest movement of a nystagmoid type.

Upon completion of the survey of over 600 miners our doctors reported only two cases of nystagmus, one of which was easily recognizable as such and the other, after a consultation of the three doctors, was labelled as doubtful, the movement being so slight and the oscillations so infrequent as to render a positive diagnosis of nystagmus inadvisable. The finding of only two cases out of such a large number of supposedly occupationally predisposed patients was indeed a surprise to all concerned and resulted in a great deal of argumentation, discussion and conjecturing as to the reasons. Innumerable opinions could, of course, be formed, among them being a questioning of the authenticity of the term miners' nystagmus and the possibility that there had been some change in the working conditions which might have eliminated the aetiological factors that had been held to cause the condition. This latter reasoning seemed to the writer to be the more logical one and resulted in an investigation to determine and to compare the working conditions of the miner today with those of former years. It is well to remember that nearly all of the text book authors were agreed that if the occupation were changed the condition of miners' nystagmus would disappear, therefore it seems logical to assume that if the factors causing the condition were to be removed or improved, even though the basic occupation were the same the condition should disappear. Another situation that must be kept in mind is the one of labor turnover, not from the standpoint of weeks or months but from the standpoint of the working lives

of miners. Owing to various unhygienic surroundings, necessitated by working underground, i. e., dust, poor ventilation, and dampness, a miners life is a short one. A miner is considered quite old at 45 or 50 years of age. This labor turnover would, of course, permit of the disappearance of the condition over a period of years, if the aetiological factors were to be removed.

My first move in the investigation was to communicate with Mr. E. D. Straub, general superintendent of the Lawrence Colliery, a man familiar over a long period of years with all phases of mining in the Anthracite region of Pennsylvania. Mr. Staub gave me some very valuable information along this line and referred me to the United States Bureau of Mines, in Washington, for still further information.

In respect to the illumination factor as a cause of nystagmus, I have gathered the following facts from the aforementioned sources: The miners of today use an electric cap lamp (worn on the hat or cap). This lamp has an intensity of about 30 candle power. This amount of light, so placed, is quite sufficient for macular fixation, even though it might be considered poor lighting according to present day standards of good illumination. These lamps known technically as Edison Model F. have a burning capacity at the rated candle power, of 12 hours. The electricity is furnished by a small two cell storage battery worn on the belt. The lamps are of the double filament type so that in case of one filament burning out the other can immediately be turned on. Prior to the development of the electric type of lamp carbide and oil lamps were in use. The carbide lamp which was vastly superior to the oil lamp had a burning capacity of 2½ hours and when fully charged had an intensity of approximately 18 candlepower but even before that period was up the lamp burned lower and lower until it finally went out. I understand that in some few mines the carbide lamps are still in use, but just as they replaced the older oil lamp so the newer electric type is replacing the carbide. Another type of lamp that is occasionally used is the safety type used to detect gas. this lamp is only used in gaseous pockets of the mines and gives a very feeble illumination, not over 8 or 10 candlepower at most. It is easily understandable how such poor light could readily produce a nystagmic condition. In justice to the writers of texts who stated that poor illumination was a factor in the aetiology of nystagmus it must be remembered that their investigations were carried on in the days of the safety, oil and carbide lamps.

The next phase of the inquiry was more difficult because of the fact that mining is carried on in many different ways, even in the same mine, that is all sorts of conditions are met up with that require all sorts of mining. It might be well to give the exact wording of my question and the answer to it from the mining experts, so that each reader may draw his own independent conclusions, which might differ from the writers. Question: "Do the miners in the Anthracite field work lying in a semi-recumbent position on their backs or sides looking up at

their work?" Answer: " 'No.' In both pitch and flat mining in the anthracite field the miners either stand or kneel while at work. In the bituminous field, I have been told, in some of the low seams the miners lie on their sides while working."

Atkinson has stated that miners nystagmus was caused by wielding a pick while lying on the side in a cramped position. From the above answer it can be seen that only occasionally is the miner required to assume this awkward position, then again the miner is not forced to use a pick as in former days, but is now supplied with pneumatic tools which permit of better positioning of the body. It seems logical to assume that the fatigue caused to the ocular muscles by assuming an awkward position for a short period of time would be repaired in the usual manner, i. e., rest, without any resultant danger of nystagmus.

I am indebted to the United States Bureau of Mines for the following information: "In physical examination of several thousand miners in various parts of the United States, the incidence of nystagmus was negative and would substantiate your statement that nystagmus is no more prevalent among miners than among other industrial groups." "The disease occurs among the miners of England." The Bureau of Mines referred me to considerable material upon the subject of Miners' nystagmus and those interested will find these references listed in the bibliography of this paper.

In conclusion it would seem from the material and experiences gathered in this paper that the condition, or disease, if it may be called a disease, of Miners' Nystagmus does not exist in this country at the present time, if it ever did exist at any time. That Nystagmus does exist amongst miners is uncontrovertial, but to no greater degree and possibly even to a lesser degree than is found in any other industry. There is little doubt but that Miners' Nystagmus is a particular type in England where undercutting is done by hand instead of machine, as in this country but it seems logical to assume that with the gradual improvement in methods of mining that are taking place in all mining countries, there should be a gradual disappearance of the condition in England. It is to be hoped that authors of texts pertaining to Ocular Diseases and to this condition in particular will, in the future, take cognizance of these facts and will not depend upon investigations done in another country, years ago, for their material thus spreading a false concept in the minds of their readers.

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RETINOSCOPY AND LAG OF ACCOMMODATION*

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In dealing with retinoscopy, we are concerned with an accommodative mechanism which is in turn controlled by a small part of a great central nervous system. Up-to-date, the central nervous system has not been taken into consideration when dealing with the ocular functions.

In order to bring out the point in mind let us take two cases which present the same refractive error. Two patients of the same age, and in good health, wear O. U. + 1.00 D. S. In one "Static retinoscopy" indicates + 0.25 D. S. and dynamically shows + 1.75 D. S. In the other patient we find "statically" O. U. + 1.00 D. S. and dynamically O. U. + 2.50 D. S. Why?

The reason rests in the fact that every individual presents variabilities in his nervous make-up. We each possess a complicated endocrine system, the secretions of which affect the behavior of *every* bodily function, including the ocular functions. A hyper-endocrine secretion will lead to a luke-tonicity of the nervous system, a hypo-endocrine secretion causing the opposite.

It is the person having an exophoria who is most apt to show less plus in his retinoscopic findings. In cases where there is 2° or more of exophoria at distance we are more apt to find almost the full plus correction retinoscopically. The objective refractive findings are not affected in the least by the phorias, but by the tonus of the entire nervous system. It is the esophore who is nervous, excitable or markedly determined. It is the exophore who tires easily, or has no ambition. However, many people who tire easily (physically) may also be very excitable.

There are cases where the dynamic findings indicate less plus than the "static." This can be expected in a highly strung individual.

Because of the fact that the behavior of accommodation is markedly affected by the entire nervous system, then no technique or method of retinoscopy will give findings which will be the same as the subjective findings. It must be remembered that we are not dealing with accommodation, but with the entire nervous system.

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It seems that the "lag of accommodation" is due to a psychologic phenomenon. Because of the fact that dynamic retinoscopy so frequently shows about +1.50 D. S. over the "static" findings, it would therefore seem that we use about 1.50 dioptres less than as is theoretically determined by the principle of geometrical optics.

When observing an object at the reading distance, there is no question but that the retinal image will be considerably larger than when the object is viewed at twenty feet or more. It is probably because of this enlargement of the retinal image (when an object is brought within the reading distance) that we make no attempt to exert more accommodation than is necessary to allow clear and comfortable vision with a minimum of accommodative energy.

It seems therefore that the presbyope who wears + 1.50 for reading uses no accommodation at all.

Accordingly Donder's table of accommodative amplitude indicates about 1.50 dioptres more than really exists. It is to be remembered that dynamic skiametry was unknown in Donder's time, and he therefore had no means of checking his findings objectively. Donder's tables correctly tabulates the *range* of accommodation, but not the amplitude. Therefore, there are no equivalents of range and amplitude of accommodation.

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STEREOSCOPIC TREATMENT AIDS

Whom to credit for a technic, an invention, or a theory is often a problem. Ideas spring up simultaneously in widely separated parts, each man's work being often unknown to the other. The airplane is an outstanding example of this. Many energies were bent on developing the flying machine in both Europe and America and several achieved practicability at about the same time. For years there was grave question as to whom should be credited with its invention; finally the Wright brothers were recognized, largely because of their superior achievements.

The recent craze for orthoptic instruments among optometrists has set up a more or less frenzied activity in their development and manufacture. The majority of new instruments quickly fall by the wayside, being mechanical modifications of old ideas. Occasionally a good thought is given birth, sometimes simultaneously by a number of persons, each man being unaware of the other's work.

An instrument to give stereoscopic orthoptic treatments is being presented to the profession in this issue of the Journal by its inventors, Drs. W. E. Tait and A. S. Hendrick of Lexington, Kentucky. The model they describe was vaguely familiar to the writer and he recalled having heard of a somewhat similar instrument during the late spring of 1931. Later the familiarity was confirmed. The other instrument had been

designed by Dr. G. L. DuPlessis, a former associate of the writer. Both instruments are mirror devices. However, stereopsis is obtained differently in the two and each has features not common to the other.

Both devices were exhibited at the last National Convention in St. Antonio and were given favorable attention. As near as can be found, both Tait and Hendrick and also DuPlessis worked on their ideas at the same time and probably the results of this creative work will be presented to the optometric profession at about the same time.

We are confident that neither man knew of the other's work, although there is enough similarity in the devices to make the coincidence obvious and yet not enough to suggest that either was a copy of the other. This type of creative work is splendid, and proper encouragement should be accorded to these optometrists.

C. C. K.

ABSTRACT

THE PHOTOMETRIC SENSIBILITY OF THE EYE AND THE PRECISION OF PHOTOMETRIC OBSERVATIONS, by E. M. Lowry, The Journal of the Optical Society of America, Vol. 21, No. 2, Feb., 1931.

This article is the result of recent research work by Dr. E. M. Lowry of the Kodak Research Laboratories of Rochester, N. Y. The author made a study of the brightness level at which the normal human eye possesses maximum sensibility for brightness differences. Interest in the question of brightness contrast arises from the fact that the ability of the eye to detect detail in an object or scene depends in a large measure upon the facility with which minute differences in brightness are perceived. The present investigation was undertaken primarily from the standpoint of the photometrician and the work was done on a photometer bench under necessarily highly specialized conditions. For example, the area of the retina stimulated was confined to the region immediately surrounding the fovea, that is, the position of maximum retinal sensibility. The experiment was carried out on six persons each of whom had a considerable amount of experience and photometric work, who acted as observers and each made a complete set of readings on three different days. In this way, eighteen separate determinations were made at each of the nine field brightnesses.

Ten settings were made at each brightness. The result of every point therefore is the average of one hundred and eighty separate readings.

The results show that for maximum of photometric sensibility, the brightness of photometric field should be adjusted so that a brightness level from twenty to thirty millieamberts is secured.

J. I. K.

ANNOTATIONS AND SOCIETY PROCEEDINGS

The American Journal of Optometry is the Official Organ of the American Academy of Optometry, as well as the Organ of the Arkansas, Delaware, Indiana, Iowa, Maine, Maryland, Michigan, Minnesota, Nebraska, North Dakota, Oklahoma, Pennsylvania, South Dakota, Vermont and West Virginia Optometric Associations.

The following gentlemen have consented to supply items of interest from their respective sections, acting in the capacity of

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PERIMETRY IN ROUTINE REFRACTION

Dr. Ralph G. Colberg, optometrist of Aberdeen, South Dakota, writes: "Probably no other branch of study of the eye has held itself out to me more interestingly than that of the visual field. Happily, today we find men within our ranks giving visual field charting no little thought and occasionally some are accomplishing some mighty fine things in their work.

"When we consider that central fixation, or the fovea, consists of an area of less than two mm. in extant is it any wonder that impending pathological conditions may exist without the knowledge of the refractionist, unless he employs some method to allay even his faintest suspicions. A patient could quite readily be given 20/20 vision and yet a well developed ring scotoma could exist. One may well consider his campimeter as a subjective method of ophthalmoscopy. By careful study and application much good can be accomplished by embracing this test in every eye examination.

"Traquair speaks of the field of vision as being compared to a hill surrounded by a sea of blindness. I know of no description of this more splendidly put. Imagine, if you will, when making this test, that you have the patient's eye focused upon the peak of the hill, i.e., central fixation, and you as the operator start at the edge of the chart with your color target out in this sea of blindness gradually working toward "shore." As you get nearer you see the "bottom," this represents the place where your patient recognizes white. Working nearer you get to the "beach," this is where blue looms up, then on "dry land" red, then green. Finally reaching the "peak" a small point designated as central or direct vision,

this point is small and you slide off of it very easily into the area again of indirect vision. The blind spot too comes in for recognition and is represented as a deep depression or a well that has as its bottom the sea of blindness. Pathological conditions such as scotoma also appear as depressions or gaps in the visual field, or might we say wells or inland seas.

"Not long ago a medical friend of mine was citing an instance where early in his practice he had difficulty with a woman patient for whom he was unable to secure more than 20/200 O. U. vision, even after a goodly number of thorough eye examinations covering a long period of time. During the interim he had been studying visual field charting and found much to his relief, upon his next examination that the patient was suffering from retrobular neuritis. This of course can occur in our every day practice and can cause many hours of wonderment and worry on the part of the optometrist as to why he cannot improve the patient's acuity, when no visible signs exist to cause this lowered acuteness of vision.

"Brombach of California has given much to the Optometrist for careful consideration. He states that evidence of impending pathology can be noted long before the most painstaking exploration of the fundus with the ophthalmoscope can offer assistance. He further states optometrists skilled in the technique of color field analysis will be able to enter new fields of useful professional endeavor, aiding in the interpretation of x-rays and other clinical tests, as well as in checking regularly progress made, whatever therapeutic measures for relief have been instituted. With all this in mind and remembering the old adage of the Greeks that, "the eyes are the windows of our soul," and might we not add the "key to our troubles"?

"One need not incur a great deal of expense to investigate or experiment in this field of endeavor in the beginning, because it will be remembered that the immortal VonGrafe himself made his first discoveries on a simple blackboard. Even then he studied Bright's disease, haemorrhages of the retina, atrophy of the optic nerve, etc., nearly one hundred years ago.

"Some are led to believe that field charting is laborious and unreliable unless patients of rather high mentality are dealt with. This is not so, because the confrontation method may be used on children and even mentally deficient adults. This method, of course, is not as accurate as the perimeter and campimeter, but serves to show that field charting can be done and accomplished very simply, and after while efficiently with a little practice on the part of the examiner.

"No conscientious optometrist will be satisfied after he has become acquainted with the possibilities of perimetry until he has included it in his every day routine. After that, and with persistent study, as Brombach says, we are qualified to sail abreast of other diagnosticians regardless of their therapy."

MASSACHUSETTS SCHOOL OF OPTOMETRY

Dr. Jos. I. Pascal, Ophthalmologist of Massachusetts, has been appointed to the staff of the Massachusetts School of Optometry. Dr. Pascal will teach physiological optics at that institution.

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SOUTH DAKOTA SOCIETY

Dr. J. H. Bechtold spoke on an "Introduction to Analytical Optometry"; Dr. W. H. Fritz spoke on "Subjective Examination" and Dr. A. Talman spoke on "Optometric Organization" before the monthly meeting of the Southern District of the South Dakota Association in Sioux Falls on January 1.

* * * * *

MAINE ASSOCIATION OF OPTOMETRISTS

Dr. Briggs S. Palmer, Dr. Howard C. Doane and Dr. Otis Douphinette were the chief speakers at the annual meeting of the Maine Association of Optometrists held at Portland January 13 and 14. All officers were re-elected and the society approved holding a Graduate Clinic under the direction of Dr. A. M. Skeffington in May.

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SAGINAW VALLEY ZONE

Case Typing and Problem cases were discussed at the recent meeting of the Saginaw Valley Zone held in Bay City, Michigan on January 7. Analytical Comparison of Findings will be the subject for the next meeting.

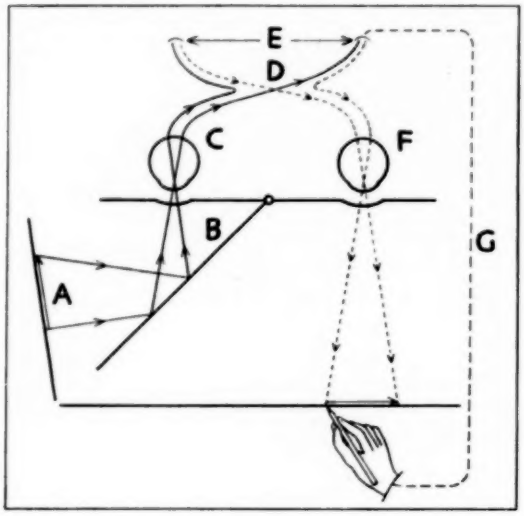
* * * * *

MADDOX CHEIROSCOPE ANNOUNCED

Descriptive literature is ready and demonstration instruments may be seen throughout the country on the Maddox Cheiroscope, the much-discussed new development in the treatment of squint and amblyopia. The technique, devised by Dr. Ernest E. Maddox of Bournemouth, England, starts with the principle of pressing the hand into service to educate the eye.

The instrument, bearing some resemblance to a stereoscope, may also be adapted to Lloyd's Campimeter method, and with accessory equipment provides the first Campimeter enabling, under stereoscopic fixation, full central and paracentral, temporal and nasal field studies. The restrictions in temporal field studies, which have handicapped Campimetry up to the present time, are solved by the inclined mirror.

Getting back to the Cheiroscope and its use in developing single binocular vision, it is based primarily on the idea of dividing the vision with an angled mirror septum so that the eyes function independently. Then the message is sent to the brain through the normal eye only,



The Cheiroscope Mirror Action

Showing how the active macular brain centers will stimulate and educate the corresponding sluggish macular brain areas and will combat any inclination towards suspenopsia. The hand acts to lead the eye and to record the visual progress. A—Object. B—Mirror. C—Normal Eye. D—Chiasm. E—Visual Brain Centers. F—Amblyopic Eye. G—Impulse from Motor Brain Centers to Hand.

while the afflicted eye is asked to translate it, by tracing the mentally-projected image with the hand on that side of a drawing board. Thus coordination between the brain and the two eyes is forced by the effort of the hand.

The animated object, plus the mental interest aroused in using the hand directed by the eye under training, makes this treatment far more effective than the still object used with the ordinary stereoscopic treatment.

Set up for tracing images, for fusing rotating objects, useful in both monocular and binocular exercises, the Cheiroscope provides for taking the three essential steps to combat amblyopic squint, (amblopia ex anopsia) namely:

1. To Restore Vision in the Amblyopic Eye
2. To Link Together in the Visual Brain Centers, Corresponding Retinal Points
3. To Build Up the Fusional Urge and Fusional Reserves.

Contributing to the design of the instrument are Dr. Maddox, eminent British ocular scientist whose name is familiar through the universal use of Maddox Rods, and Dr. Ralph L. Lloyd of Brooklyn, New York, prominent authority on the subject of Campimetry. The manufacturer and distributor is American Optical Company, which will gladly supply literature or a demonstration through its widespread system of servicing branches.

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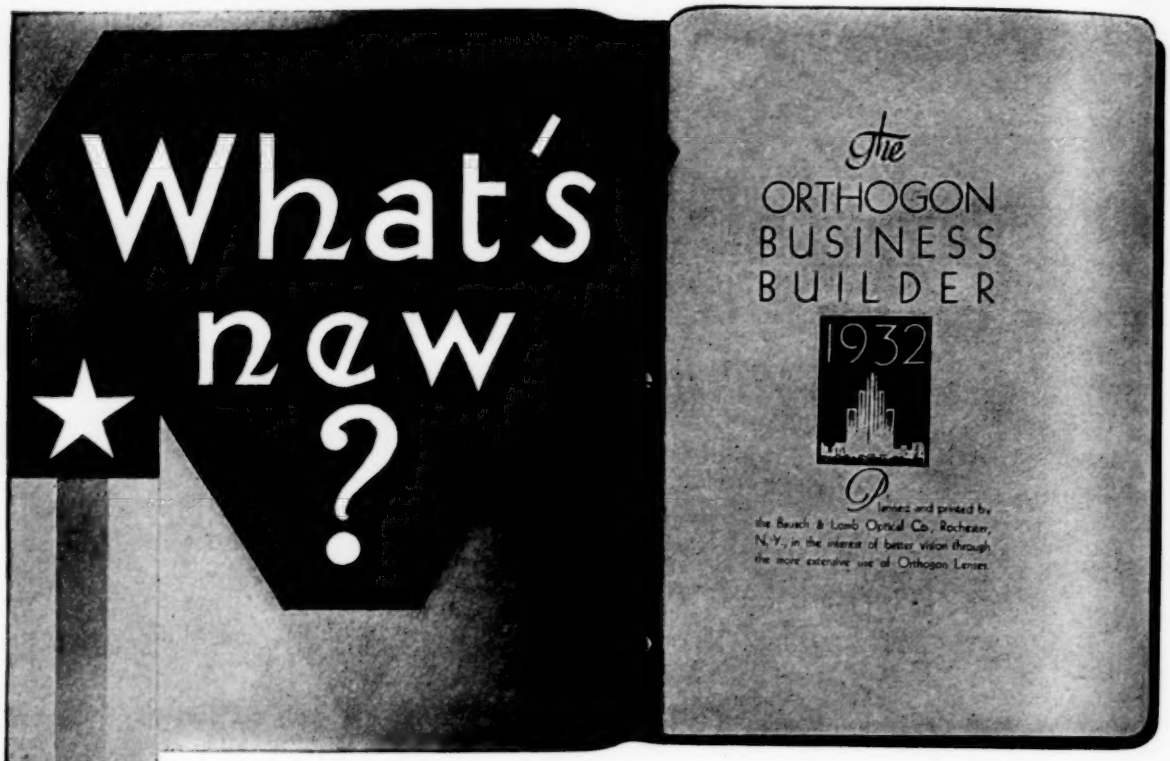
PENNSYLVANIA OPTOMETRIC ASSOCIATION

Acting according to recommendation at the Pennsylvania Optometric State Convention held at Hazleton from October 4th to the 7th inclusive, Dr. J. C. Strauss, Allentown, President of the State Society, has appointed a special committee to revise and re-write the State By-Laws of the society. This committee will be called together in the early part of 1932, and activities along these lines will be started at once. The By-Laws of the American Optometric Association will be used as a model in formulating the new By-Laws.

The following secretaries of the local state societies have been appointed by Dr. Strauss to serve on the Committee: Dr. H. L. Bautsch, Allentown; Dr. M. L. Blum, Hazleton; Dr. J. G. Cotner, Kingston: Dr. George R. Huber, Lancaster: Dr. Thomas H. Martin, Pittsburgh: Dr. J. C. Neill, Philadelphia; Dr. Samuel Prussin, Erie; Dr. P. J. Wenger, Reading; and Dr. R. J. Zimmermann, Harrisburg.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We can't disclose the Business Builder program at this time. Across the page is a preview of one of the features. Your distributor's representative will disclose the balance of the program early in February. Watch for him—you will find his 1932 story engrossing.